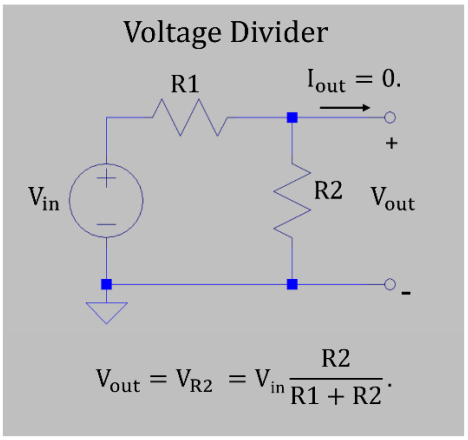
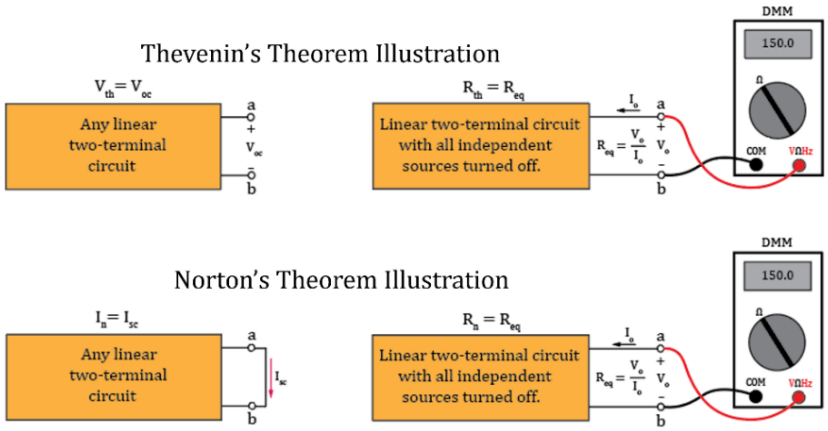
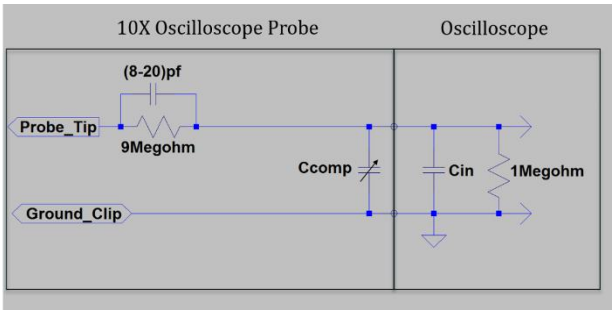
ECEN 350 – Equation Sheet 1 (9/09/2024)

Capacitor Impedance: $Z_C = X_C\angle(-90^\circ) = -jX_C$, with $X_C = 1/\omega C = 1/2\pi fC$.
Inductor Impedance: $Z_L = X_L\angle 90^\circ = jX_L$, with $X_L = \omega L = 2\pi fL$.
Power $P = VI = I^2R = V^2/R$. Average AC Power $P = V_{rms}I_{rms}\cos(\theta)$.



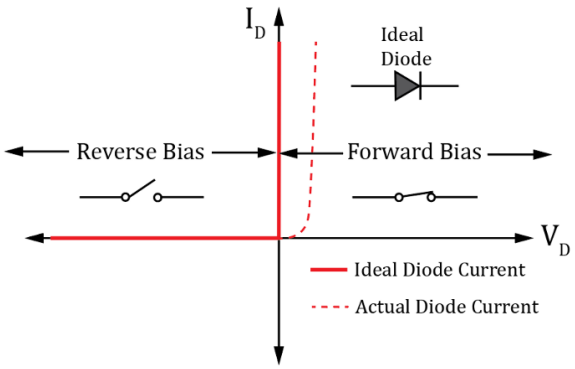




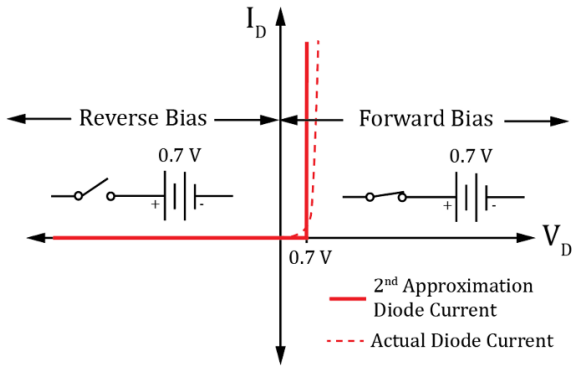
Shockley Diode Equation: $I_D = I_S\left(e^{V_D/nV_T} - 1\right)$ A, where I_S is the reverse saturation current, V_D is applied voltage across the Diode, V_T is referred to as the thermal voltage, and n is an ideality factor ranging from 1 – 2. Assume n = 1 for ECEN 350.

Thermal Voltage: $V_T = \frac{kT_k}{q}$, where $k = 1.38 \times 10^{-23}$ J/K is Boltzmann's constant, T_K is the temperature in Kelvin, and $q = 1.6 \times 10^{-19}$ C is the magnitude of the charge of an electron or proton. $V_T \approx 25$ mV @ 20 °C.

Ideal Diode Model – 1st Approximation



2nd Approximation for Silicon pn Junction Diode
Simplified Diode Model



Junction Temperature: $T_J = T_A + \Delta T_J = T_A + PR_{\theta JA}$. $T_J = T_A + PR_{\theta JA}$, where T_A is the ambient temperature, P is the power dissipated, and $R_{\theta JA}$ is the thermal resistance in ˚C/W.

Diode DC Forward Resistance, $R_F = \frac{V_D}{I_D}$. Diode Bulk Resistance, $R_B = \frac{\Delta V_D}{\Delta I_D}$.

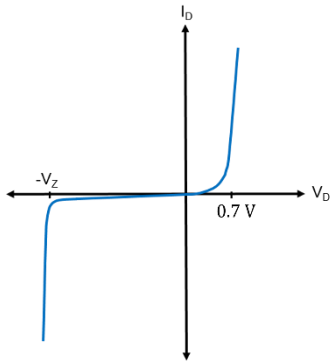
Standard Silicon pn Junction Diode
Knee Voltage $V_K = 0.7$ V

Zener Diode
Knee Voltage $V_K = 0.7$ V
Reverse Breakdown
$V_R = -V_Z$.

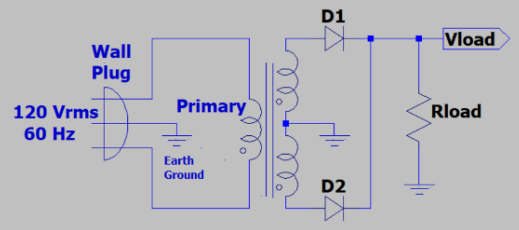
(LED) Light Emitting Diode

Schottky Diode
Knee Voltage $V_K = 0.3$ V

Zener Diode Characteristics



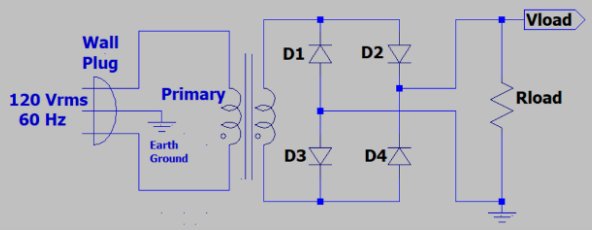
Full-Wave Rectifier



$V_{peak\_load} = V_{peak\_prim}/2N$, where $N = N_{prim}/N_{sec}$ for 1st Diode Approximation.

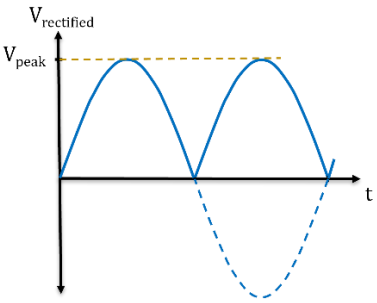
$V_{peak\_load} = [(V_{peak\_prim}/2N) - 0.7\ V)]$ for 2nd Diode Approximation.

Bridge Rectifier

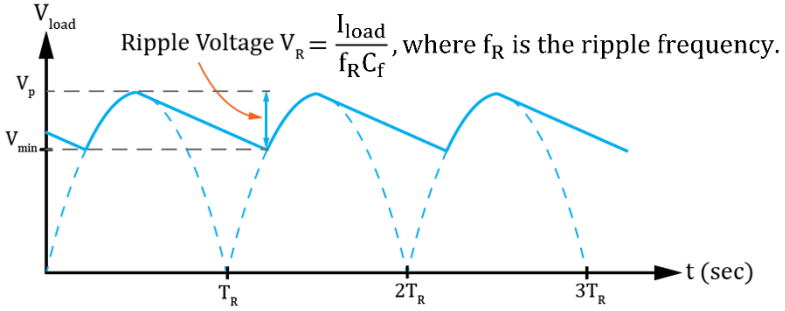


$V_{peak\_load} = V_{peak\_prim}/N$, where $N = N_{prim}/N_{sec}$ for 1st Diode Approximation.

$V_{peak\_load} = [(V_{peak\_prim}/N) - 1.4\ V)]$ for 2nd Diode Approximation.



The Above Full-Wave Rectified Waveform has the Following Values:
$V_{avg} = 0.637(V_{peak})$. $V_{rms} = 0.707(V_{peak})$.

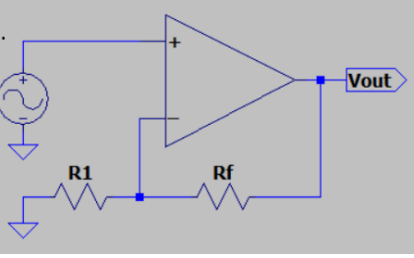


The ripple frequency $f_R = 1/T_R$, is twice the frequency (half the period) of the non-rectified input waveform.

Non-Inverting Amplifier

$A_v = \frac{V_{out}}{V_{in}} = \left(1 + \frac{Rf}{R1}\right)$.

$Z_{in} = \frac{V_{in}}{I_{in}} = \infty$.



Inverting Amplifier

$A_v = \frac{V_{out}}{V_{in}} = -\frac{Rf}{R1}$.

$Z_{in} = \frac{V_{in}}{I_{in}} = R1$.